US006015959A

United States Patent [19]

Slepian et al.

[11] **Patent Number: 6,015,959**

[45] **Date of Patent: Jan. 18, 2000**

[54] **MOLDED CASE ELECTRIC POWER SWITCHES WITH CAM DRIVEN, SPRING POWERED OPEN AND CLOSE MECHANISM**

[75] Inventors: **Robert Michael Slepian**, Murrysville, Pa.; **William Christopher Farrow**, Germantown; **Michael Thomas Little**, Cedarburg, both of Wis.; **H. Richard Beck**, Corapolis, Pa.; **William George Eberts**, Moontownship, Pa.; **David Curtis Turner**, Imperial, Pa.

[73] Assignee: **Eaton Corporation**, Cleveland, Ohio

[21] Appl. No.: **09/183,464**

[22] Filed: **Oct. 30, 1998**

[51] **Int. Cl.**^{7} **H01H 5/00**

[52] **U.S. Cl.** **200/400**; 200/401; 200/424

[58] **Field of Search** 200/400, 401, 200/424

[56] **References Cited**

U.S. PATENT DOCUMENTS

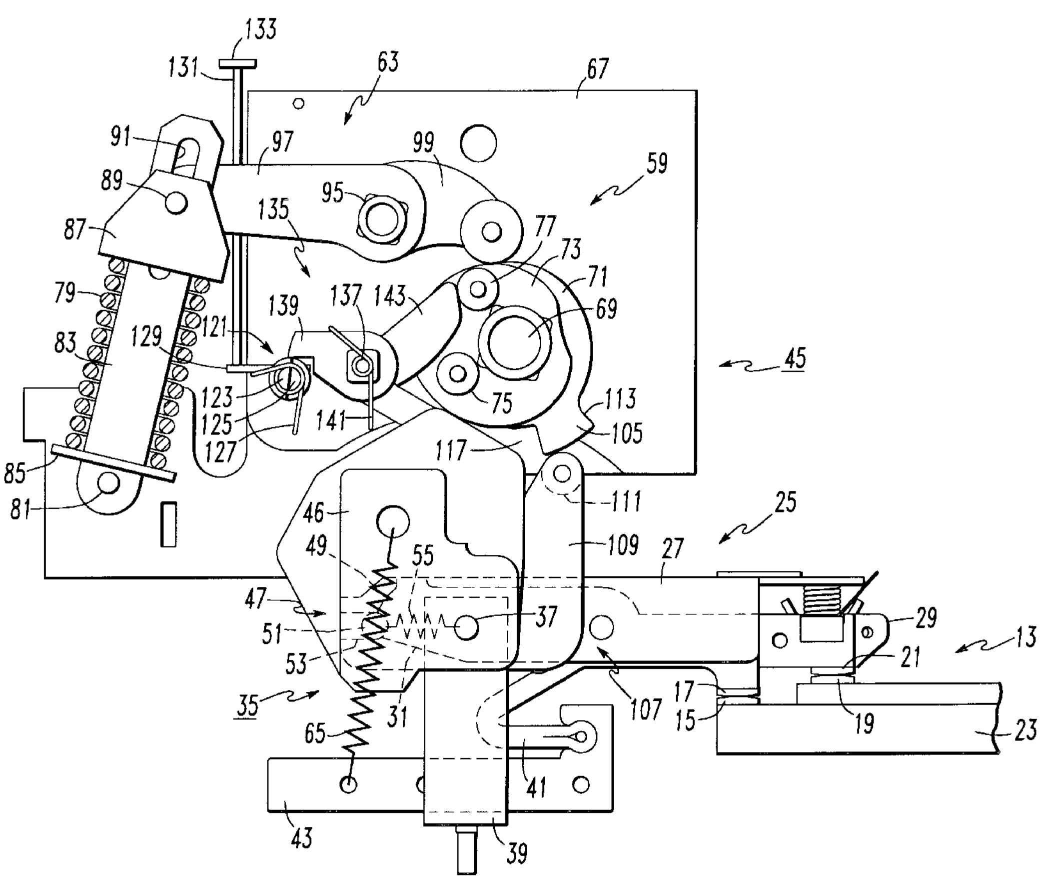
3,134,879	5/1964	Gauthier et al.	200/169
4,114,005	9/1978	Maier et al.	200/153
4,264,796	4/1981	Nelson et al.	200/153
5,057,806	10/1991	McKee et al.	335/9
5,280,258	1/1994	Opperthauser	335/162

Primary Examiner—Michael L. Gellner
Assistant Examiner—Nhung Nguyen
Attorney, Agent, or Firm—Martin J. Moran

[57] **ABSTRACT**

Molded case electric power switches such as circuit breakers, disconnects and transfer switches have an energy storage spring which rotates a cam assembly to close and initiate opening of the switch contacts. The cam assembly includes a drive cam with a cam lobe which engages a drive cam follower on the moving contact assembly. Due to space limitations, the cam assembly is positioned so that the drive cam follower initially moves toward the cam assembly during closing. To accommodate for this, the cam lobe has a generally radial leading edge to prevent binding of the drive cam follower. A single latch mechanism latches the cam assembly in a spring charged position and in a closed position. A Y-shaped latch member has one leg which is engaged by a latch, a second leg which engages stops on the drive cam at the charged position and the closed position, and a third leg which sequentially engages the stops to reset the latch mechanism. The cam assembly, a charging mechanism including a rachet wheel and handle, the latch mechanism and the energy storage spring are all mounted between and supported by a pair of side plates. In a multi-pole switch, the drive cam engages the moving contact assembly of one pole which is coupled to the moving contact assemblies of the other poles by a cross-bar.

15 Claims, 8 Drawing Sheets



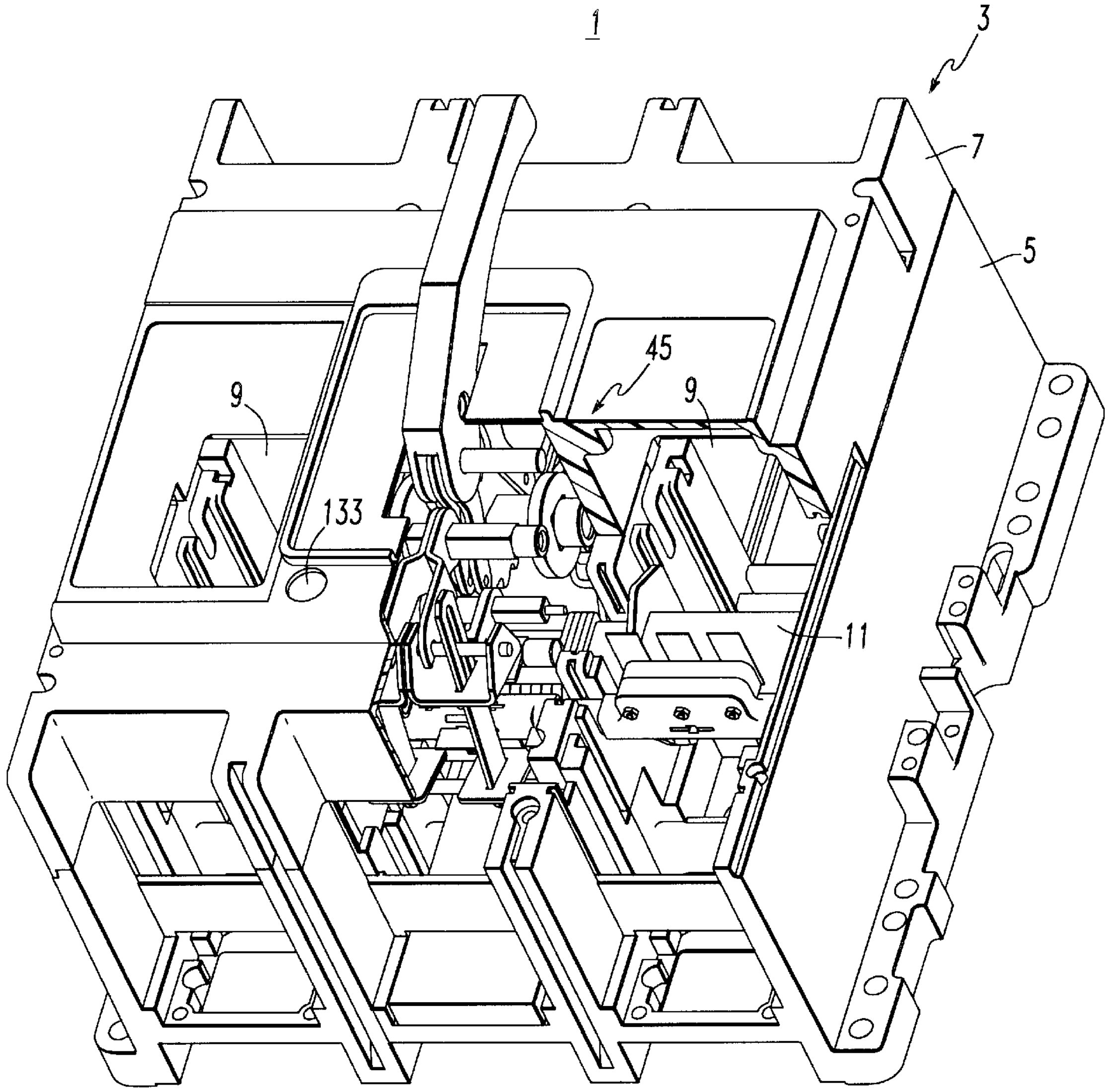


FIG. 1

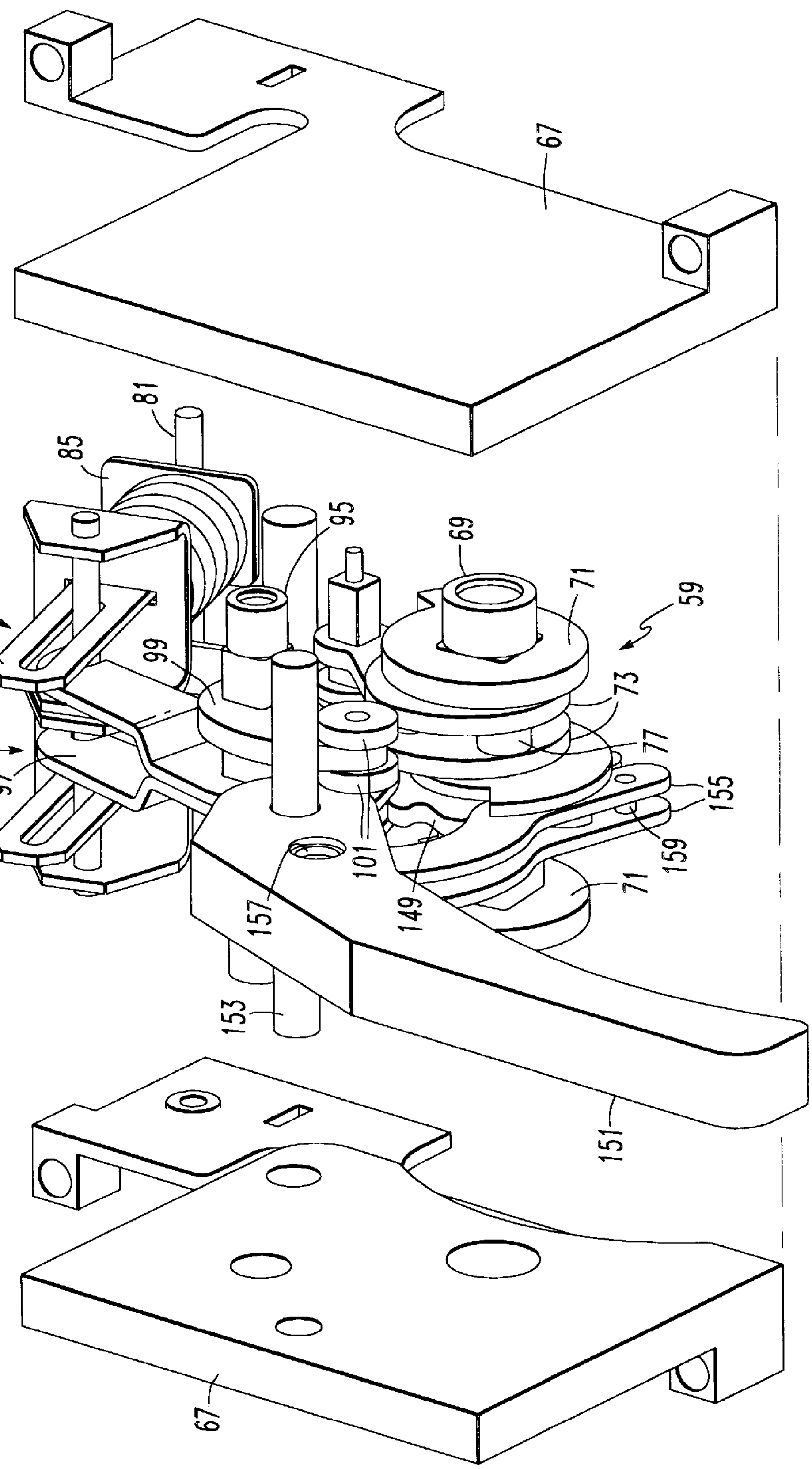
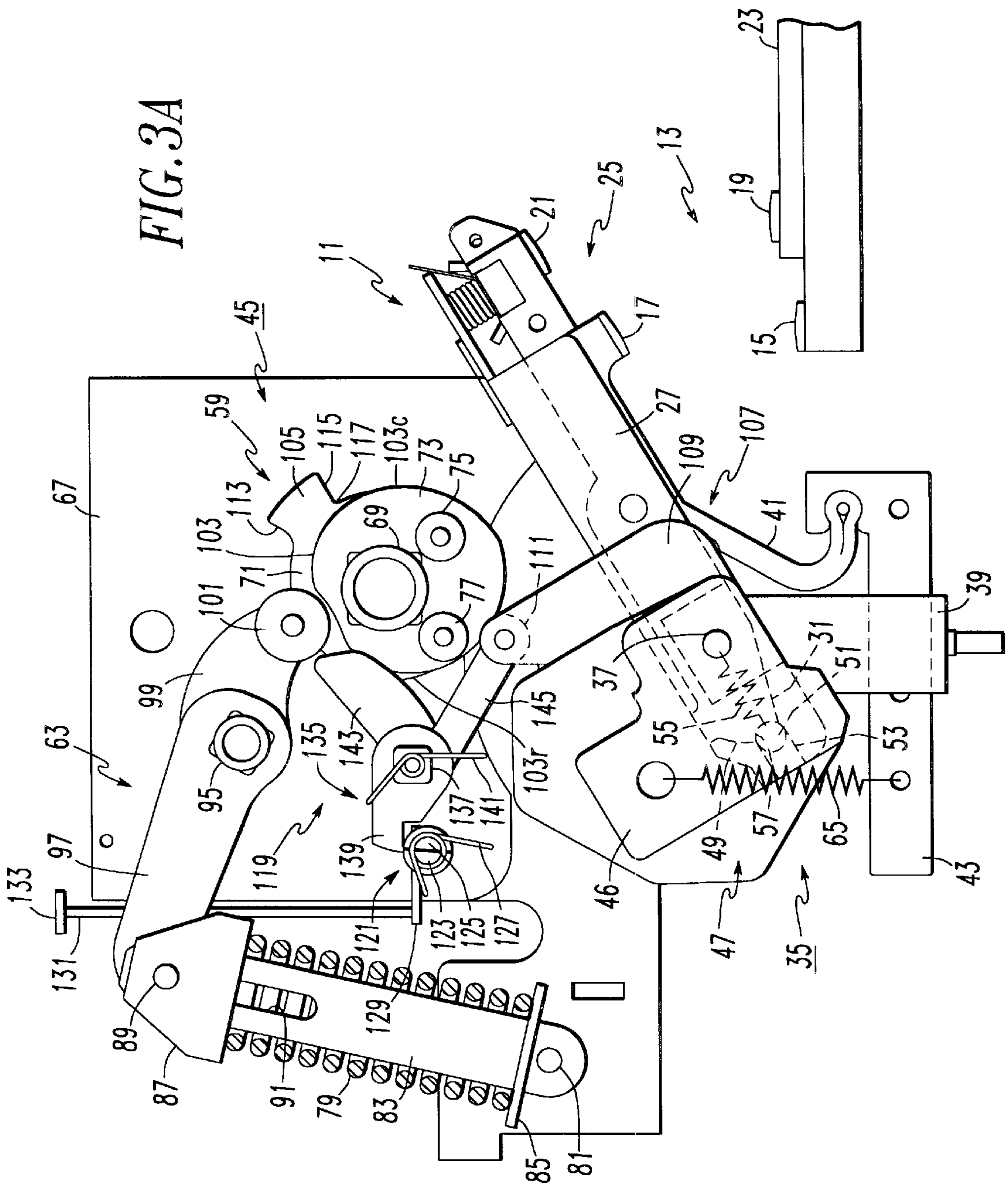

67
81
85
95
69
71
59
61
83
99
73
63
77
97
155
101
159
157
149
71
153
151
67

FIG. 2



11
13
15
17
19
21
23
25
27
31
35
37
39
41
43
45
46
47
49
51
53
55
57
59
63
65
67
69
71
73
75
77
79
81
83
85
87
89
91
95
97
99
101
103
103c
103r
105
107
109
111
113
115
117
119
121
123
125
127
129
131
133
135
137
139
141
143
145

FIG. 3A

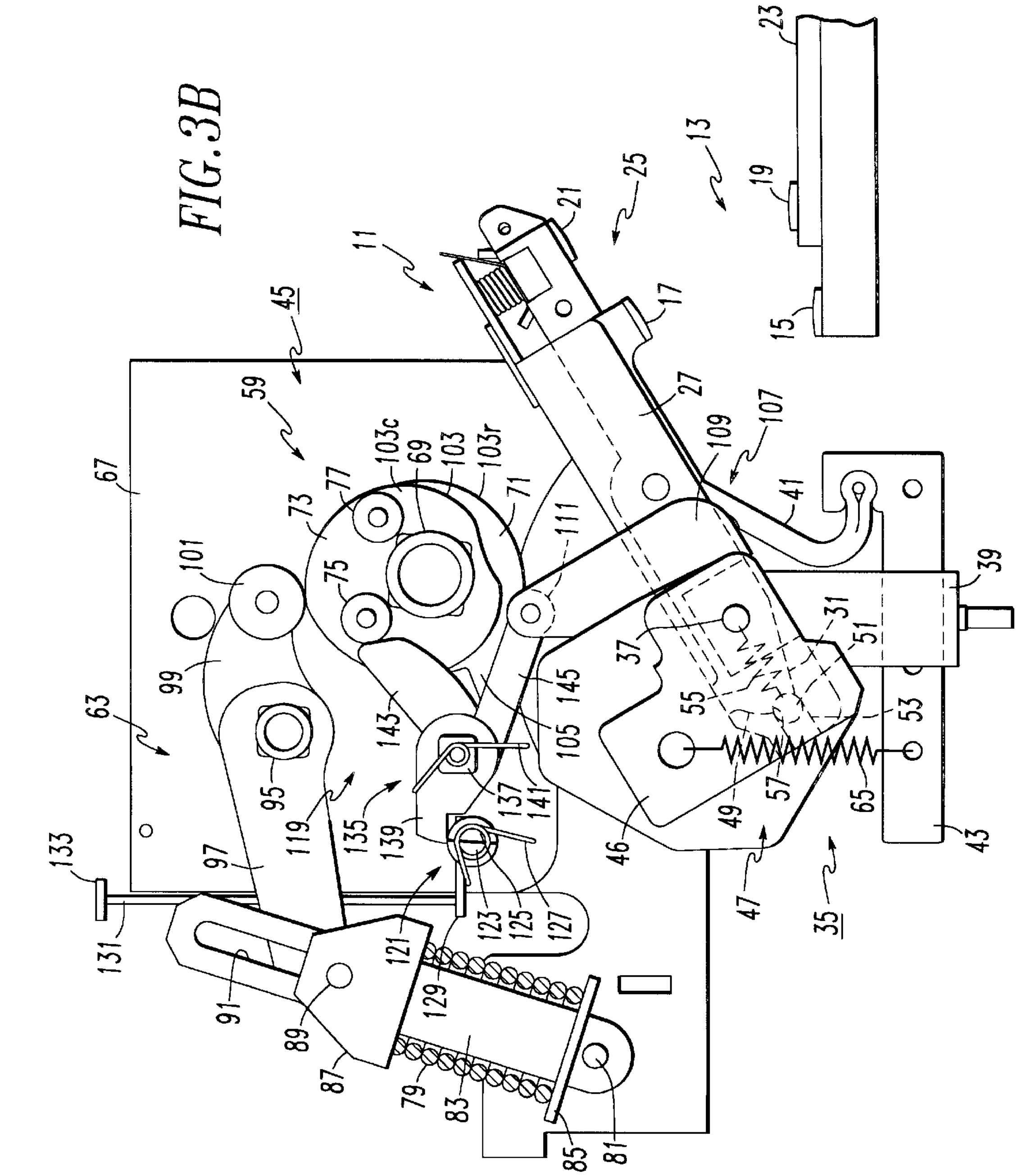


FIG. 3B

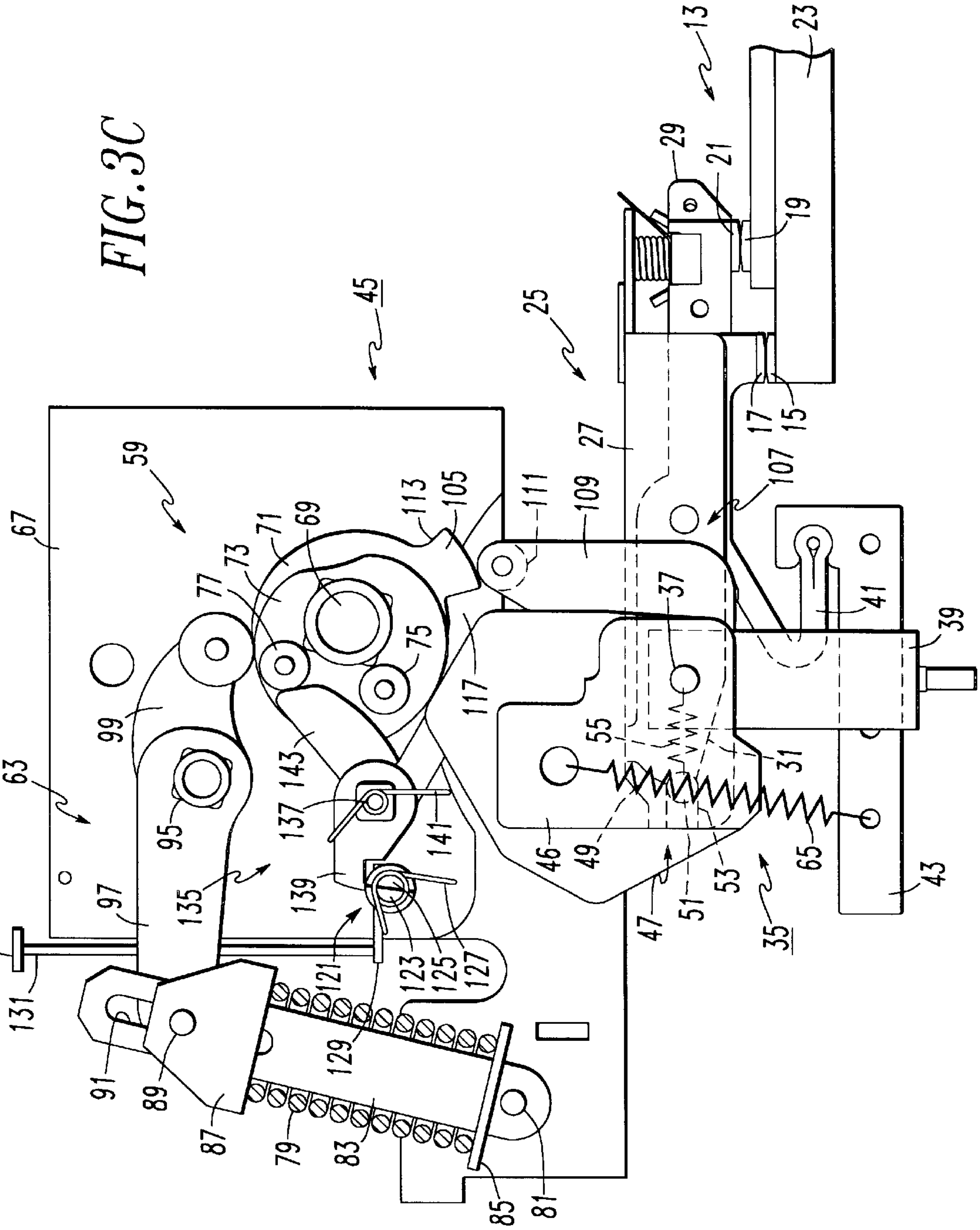

13
23
29
21
19
45
25
17
15
27
107
59
67
113
105
111
109
69
71
73
77
37
41
39
75
117
99
55
31
143
63
95
137
141
46
49
53
65
43
97
135
139
47
51
35
133
121
123
125
127
131
129
91
89
87
79
83
85
81

FIG. 3C

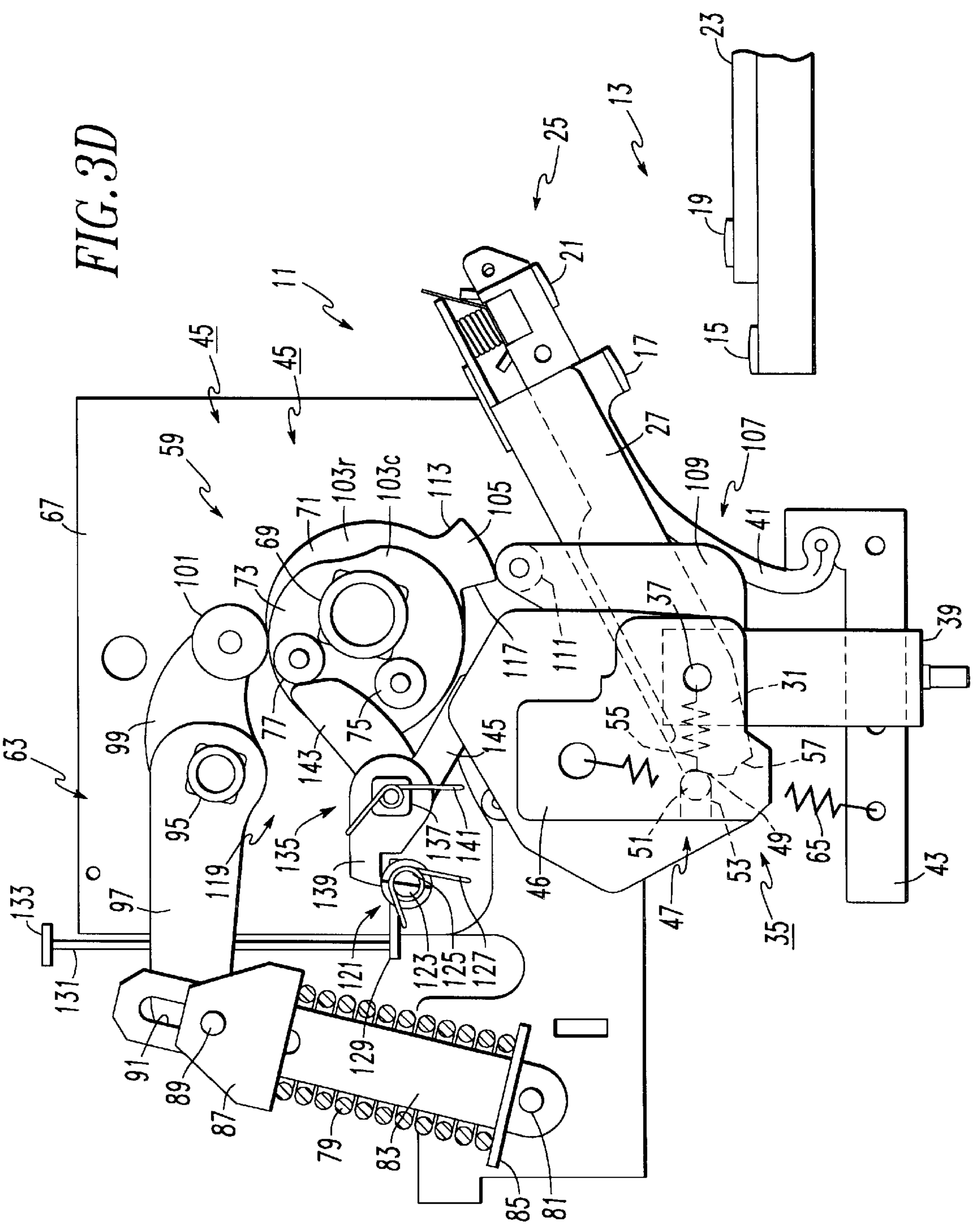

11
13
15
17
19
21
23
25
27
31
35
37
39
41
43
45
46
47
49
51
53
55
57
59
63
65
67
69
71
73
75
77
79
81
83
85
87
89
91
95
97
99
101
103r
103c
105
107
109
111
113
117
119
121
123
125
127
129
131
133
135
137
139
141
143
145

FIG. 3D

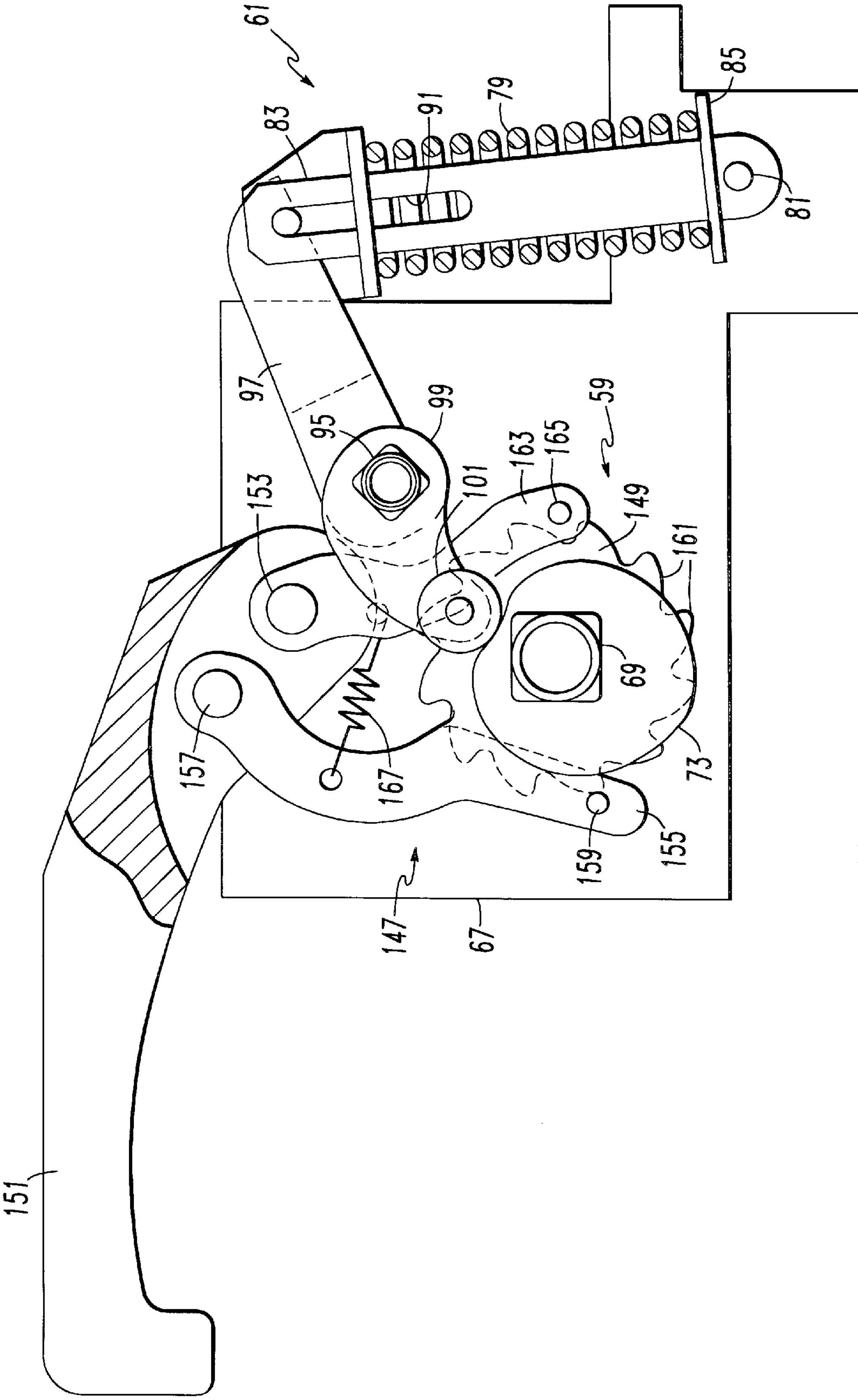

61
83
91
79
85
81
97
99
95
59
163
165
101
153
149
161
69
73
157
167
155
159
147
67
151

FIG. 4

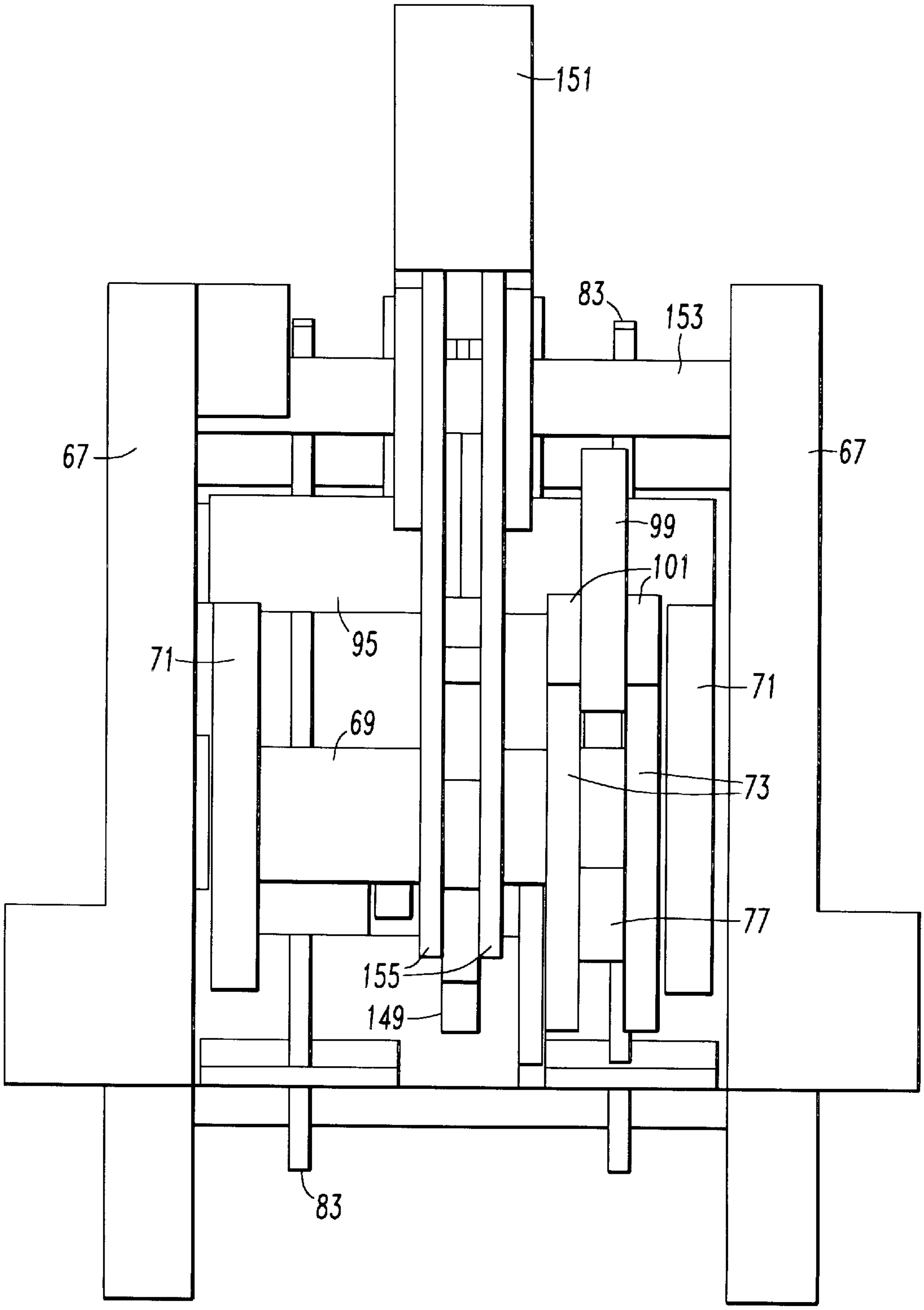


FIG. 5

MOLDED CASE ELECTRIC POWER SWITCHES WITH CAM DRIVEN, SPRING POWERED OPEN AND CLOSE MECHANISM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to switches used in electric power distribution systems such as circuit breakers, disconnects and transfer switches. More particularly, it relates to the operating mechanism for opening and closing the contacts of molded case power switches, and specifically an operating mechanism which uses energy stored in a spring and delivered through a cam assembly to close and open the switch contacts.

2. Background Information

Switches used in electric power distribution systems are well known. Such switches include circuit breakers which provide overcurrent and short circuit protection. Similar switches without such protection are used as disconnects to isolate a particular load or section of the distribution system and as transfer switches to switch between sources such as a utility and an emergency power generator.

Different types of switching mechanisms are used for such power switches in different parts of the power distribution system depending in part upon the current to be handled by the particular switch. The various switches are designed to handle up to a specified "rated" current. One of the factors related to the rated current is the amount of force needed to close the switch and hold it closed against the magnetic repulsion force generated by the current.

Molded case switches, so named because the mechanism is mounted in a molded, electrically insulative resin housing, typically have a rated current of from 3 to 2,500 amperes. Conventionally, such molded case switches have a spring powered toggle mechanism which opens the contacts. The opening spring is charged by closing of the switch. This is performed manually by a handle or can be effected remotely with a motor operator.

Larger power switches which are required to withstand the larger magnetic repulsion forces generated at the higher current ratings, require larger forces to close the contacts. Typically, such higher closing forces cannot be generated by a direct acting manual handle. Thus, the larger power switches have a closing spring which releases stored energy to close the contacts. This closing spring may be charged manually, usually by a handle acting through a rachet mechanism, or electrically by a motor operator. Typically, these power switches have a closing cam driven by the closing spring which rotates a pole shaft to in turn close the contacts. Separate latches are used to close and open the contacts.

Improvements in molded case switches for electric power distribution systems have resulted in switches with higher current ratings. However, the closing forces required for these molded case switches with higher current ratings cannot be conveniently generated by the direct acting handle or the conventional motor operators designed for such switches. Furthermore, the conventional spring driven closing mechanisms of the larger circuit breakers, with their pole shaft and other components are too large for adaptation to molded case switches with higher rated currents.

Therefore, there is a need for improved molded case switches for electric power distribution systems with extended current ratings.

More particularly, there is a need for such improved molded case switches which incorporate a closing spring.

There is an additional need for a mechanism with a closing spring which can be accommodated in the conventional molded casing.

There is a further need for such a molded case switch which incorporates a close spring but which does not require complete redesign of the entire switch.

SUMMARY OF THE INVENTION

These needs are others are satisfied by the invention which is directed to a molded case electric power switch which can be accommodated in the already available molded casing yet incorporates a close spring. The novel operating mechanism of this improved molded case switch utilizes a drive cam to directly engage the existing moving contact assembly.

More particularly, the invention is directed to a molded case electric power switch which includes an operating mechanism incorporating a cam assembly including a cam shaft, a drive cam, an energy storage spring and means coupling the energy storage spring to rotate the drive cam. Because of the limited space available in the molded casing, the drive cam has a cam lobe configured to engage the moving contact assembly to close the contacts, and yet disengage from the moving contact assembly as the drive cam is rotated to an open position. With the drive cam clear of the moving contact assembly, an opening spring biases the moving contact assembly to open the contacts. The moving contact assembly includes a cam follower which, because of the positioning of the components dictated by the limited space available, moves closer to the cam shaft as it is engaged by the cam lobe. In order to prevent binding, the cam lobe has a leading edge configured to allow this movement by the cam follower toward the cam shaft initially during closing. Preferably, the leading edge of the drive cam lobe is configured to be generally radial to the cam shaft. The drive cam lobe has a trailing edge which forms a notch accommodating release of the drive cam follower from the moving contact as the drive cam is rotated to the open position.

The energy storage spring rotates the drive cam to close the main contacts of the switch and then rotates the drive cam further to an open position to allow the contacts to be opened by the opening spring. The energy storage spring is charged by a spring cam mounted on the cam shaft and coupled to the energy storage spring through a coupling link. This spring cam has a charging profile which stores energy in the spring as the cam shaft is rotated by a spring charging mechanism, and an energy release portion over which the spring releases energy to rotate the spring cam and with it the drive cam. The operating mechanism also includes a latch mechanism latching the cam assembly in a charged position with the spring fully charged, and also latching the cam assembly with the drive cam in the closed position in which the separable contacts are closed.

A single latch member is employed to latch the cam assembly in both the charged position and the closed position. The latch mechanism includes a latch which is actuated a first time to close the separable contacts and a second time to open the contacts. The latch mechanism also includes a Y-shaped latch member having a first leg which is engaged by the latch, and a second leg which engages a first stop on the cam assembly to retain the cam assembly in the charged position until the latch is released the first time. This second leg also engages a second stop on the cam assembly to retain the cam assembly in the closed position until the latch is released the second time. The latch member further includes a third leg which is engaged by the cam assembly to relatch the latch member following release of the latch the first and second times. This third leg of the latch member is actuated by the first stop to reset the latch during closing of the contacts, and is engaged by the second stop to again reset the latch during opening of the contacts.

The spring charging mechanism includes a rachet wheel on the cam shaft, and a handle mechanism which incrementally rotates the rachet wheel.

The operating mechanism of the invention is a very compact but powerful mechanism with a closing spring. All of the major components including the cam assembly, the energy storage spring and its coupling to the cam assembly, the rachet wheel, and if provided, the handle mechanism, as well as the latch mechanism, are mounted between and supported by a pair of side plates supported in the molded casing.

For multi-pole circuit breakers a single operating mechanism operates the moving contact assembly of one pole, typically the center pole, with the other poles being simultaneously operated by a cross-bar.

BRIEF DESCRIPTION OF THE DRAWINGS

A full understanding of the invention can be gained from the following description of the preferred embodiments when read in conjunction with the accompanying drawings in which:

FIG. **1** is an isometric view with some parts removed and other parts cut away of a circuit breaker incorporating the invention.

FIG. **2** is a partially exploded isometric view of an operating mechanism which forms part of the circuit breaker of FIG. **1**.

FIG. **3**A is an elevation view through the operating mechanism of FIG. **2** taken along the line **3**—**3** with the contacts open and the spring uncharged.

FIG. **3**B is a view similar to that of FIG. **3**A but with the contacts open and the spring charged.

FIG. **3**C is a view similar to FIG. **3**A shown with the contacts closed and the spring partially charged.

FIG. **3**D is a view similar to FIG. **3**A shown with the contact arm blown open and with the spring partially charged.

FIG. **4** is an end elevation view of the operating mechanism.

FIG. **5** is an elevation sectional view showing the charging mechanism in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention will be described as applied to a molded case circuit breaker; however, it will be apparent that the invention has application to other molded case electric power switches for electric power distribution systems.

Referring to FIG. **1**, the molded case circuit breaker (mccb) **1** forming the electric power switch of the invention includes a molded casing **3** made of an electrically insulative resin, such as, for instance, a glass-filled polyester, having a base section **5** and a cover **7**. The base **5** is divided into compartments **9** each housing a pole **11** of the circuit breaker. Exemplary circuit breaker **1** is a 3-pole breaker, but the invention can also be applied to circuit breakers with other numbers of poles.

As shown in FIGS. **3**A–**3**D, each pole includes a set of separable contacts **13** including a stationary main contact **15**, a moving main contact **17**, and stationary and moving arcing contacts **19** and **21**. These poles **11** can be of the type shown in the circuit breaker described in U.S. Pat. No. 5,057,806 which is hereby incorporated by reference. The stationary main contact **15** and the stationary arcing contact **19** are both mounted on a line side conductor **23**. The moving main contact **17** and moving arcing contact **21** are supported by moving contact assembly **25**. This moving contact assembly **25** includes a contact arm **27** to which the moving contacts **17** and **21** are fixed adjacent a free end **29**. A second end **31** of the contact arm **27** is mounted for pivotal rotation by a contact arm carrier **35** which, in turn, is pivotally mounted by a fixed pivot pin **37** supported by a bracket **39**.

The contact arm **27** can be rotated between the closed position shown in FIG. **3**C and the open position shown in FIG. **3**A in a manner to be described to open and close the separable contacts **13**. The contact arm **27** is connected by flexible shunts **41** to a load side conductor **43**, so that with the separable contacts closed, an electrical path is established between the line conductor **23** and a load conductor **43** through the separable contacts **13**, the contact arm **27**, and the flexible shunts **41**.

Normally, the contact arm **27** is moved between the opened and closed positions by an operating mechanism **45** to be described. However, as is common, the separable contacts **13** can be blown open before the operating mechanism **45** operates in response to very high overcurrents such as caused by a short circuit. Such high currents generate magnetic repulsion forces which tend to rotate the contact arm towards the open position. The contact arm **27** is also mounted on the pivot pin **37** and is coupled to the contact arm carrier **35** by blow open coupling **47** which includes a camming surface **49** on the second end **31** of the contact arm **27** which engages a pin **51** biased in slots **53** in the carrier **35** against the camming surface **49** by springs **55**. A notch **57** in the camming surface **49** normally couples the contact arm **27** to the contact carrier for movement therewith. However, the magnetic repulsion force generated by a short circuit is sufficient to rotate the arm **27** while the contact arm carrier **35** remains stationary by forcing the pin **51** to disengage from the notch **57** allowing the contact arm to rotate to the position shown in FIG. **3**D.

As mentioned, normally the contact arm **27** is rotated between the opened and closed positions by the operating mechanism **45**. The operating mechanism **45** engages the moving contact assembly **25** of the center pole **11** of the circuit breaker. As is well known, the contact arm carrier **35** for all of the poles **11** are interconnected, and therefore are rotated together, by a cross-bar **46**.

Referring to FIG. **2**, as well as FIGS. **3**A–**3**D, the operating mechanism **45** includes a cam assembly **59**, energy storage spring assembly **61**, a coupling **63** which couples the energy storage springs to the cam assembly, and an opening spring **65**. The operating mechanism **45** also includes a pair of side plates **67** supported in the base **5** in spaced relation on either side of the center one of the poles **11**.

The cam assembly **59** includes a cam shaft **69** journalled in the side plates **67**. Mounted at opposite ends of the cam shaft **69** are a pair of drive cams **71**. Also mounted on the cam shaft **69** are a pair of spring cams **73** separated by a pair of stops **75** and **77**. Except for cylindrical ends which are journalled in the side plates **67**, the cam shaft **69** has a square cross section which engages square apertures in the drive cams **71** and spring cams **73** so that the cams are angularly fixed relative to each other and rotate as a unit.

The energy storage spring assembly **61** includes a pair of helical compression springs **79**. The springs **79** are mounted between the side plates **67** by a common mounting pin **81** journalled in the side plates. For each spring **79**, an elongated spring guide **83** is pivotally mounted at one end on the common mounting pin **81**. A support plate **85** fixed to the guide adjacent the mounting pin supports the lower end of the spring **79**. A clevis **87** bears against the upper end of the spring and is pivotally connected to the associated spring guide **83** by a common clevis pin **89** which extends through elongated slots **91** in the spring guides. For lower current ratings, a single energy storage spring **79** can be sufficient.

The energy storage spring or springs **79** are coupled to the cam assembly **59** by the coupling **63** in the form of a follower link. The follower link **63** includes a follower shaft **95** journalled in the side plates **67** and having a square shaft. A bifurcated link **97** engages the square shaft and the common clevis pin **89** within the two devises **87**. The follower link **63** also includes a rocker arm **99** mounted on the square follower shaft **93** and having a pair of rollers **101** at the free end.

The spring cams **73** of the cam assembly **59** have a cam profile **103** on their peripheral surface against which the rollers **101** bear to couple the spring **79** to the cam assembly **59**. The cam profile **103** has a charging portion **103*c*** and an energy release portion **103**R. The cam charging portion **103*c*** increases in radius as the cam assembly is rotated counterclockwise, in a manner to be described, as shown in FIGS. **3A–3D**. Thus, as the cam assembly rotates from the uncharged position shown in FIG. **3A**, to the charged position shown in FIG. **3B**, the increasing radius of the profile **103*c*** results in compression of the springs **79**. At the end of the charging portion **103*c*** of the cam profile, the radius of the cam reaches a maximum at about 170 degrees of rotation from the uncharged position of FIG. **3A** and then begins to decrease in magnitude. Throughout the energy release portion **103*c*** of the cam profile **103**, the radius of the spring cam continues to decrease. This decrease in the radius of the spring cam with rotation in the counterclockwise direction results in the spring driving the cam assembly.

The operating mechanism **45** closes the separable contacts **13** by engagement of cam lobes **105** on the drive cams **71** with the moveable contact assembly. These cam lobes **105** engage a cam follower **107** on the moving contact assembly **25**. The cam follower **107** includes a bracket **109** with legs which straddle the contact arm **27** and rollers **111** mounted on the bracket which engage the cam lobes **105**. One of the difficulties in incorporating a spring-powered operating mechanism in a molded case circuit breaker is the limited space available. This limited space dictates that the cam follower **107** be positioned relative to the cam assembly **59** such that as the cam lobe **105** initially engages the cam follower **107**, the cam follower moves through an arc which brings it closer to the drive cam **71**. This precludes having a cam lobe **105** which gradually increases in radius because the tendency for the cam follower to move closer to the drive cam initially would cause the mechanism to jam. Therefore, the cam lobes **105** have a leading edge **113** which accommodates for the initial movement of the cam followers toward the drive cam. Preferably, this leading edge is radial relative to the cam shaft **69**. If this leading edge **113** of the cam lobe **105** is raked forward, the mechanism will bind. If it is raked rearward too much, it will hook the follower and jam. Thus, this leading edge **113** can be raked rearward to some extent, but preferably it is radial to the cam shaft **69**.

The separable contacts **13** are opened by continuing the counterclockwise rotation of the cam assembly. The cam lobes **105** have a trailing edge **115** which forms a notch or recess **117** into which the cam follower **107** drops allowing the opening spring **65** to rapidly rotate the contact arm to the open position.

The cam assembly **59** is latched in a charged position and a closed position by a latch mechanism **119** which forms part of the operating mechanism **45**. The latch mechanism includes a latch **121** in the form of a D-shaft **123** also journalled in the side plate **67**. This D-shaft **123** has a notch **125** extending transversely through the shaft. A torsion spring **127** biases the D-shaft **123** to a latched position. A release lever **129** from extending transversely from the D-shaft **123** is engaged by an extension **131** on a push-button **133** to rotate the D-shaft to an unlatched position.

The latch mechanism **119** also includes a Y-shaped latch member **135** mounted on a shaft **137** journalled between the side plates **67**. This Y-latch member **135** has a first leg **139** which is biased against the D-shaft **123** by a torsion spring **141**. A second leg **143** of the Y-latch member **135** successively engages the stops **75** and **77** to latch the cam assembly in the spring fully charged and partially charged positions as will be described. The third leg **145** serves as a reset lever which is engaged by the stops **75** and **77** to reset the latch mechanism, also as will be described.

The operating mechanism **45** also includes a spring charging mechanism **147** for charging the energy storage springs **79**. As best viewed in FIG. **4**, this manual charging mechanism **147** includes a ratchet wheel **149** keyed on the cam shaft **69** by the square configuration of the shaft and the opening in the ratchet wheel. An elongated handle **151** is pivotally mounted on a shaft **153** journalled in the side plate **67**. A pair of drive links **155** are pivotally connected to the handle by a pin **157**. A drive pin **159** extending between the free ends of the drive links **155** which straddle the ratchet wheel **149** engages teeth **161** on the ratchet wheel. A pair of stop links **163** are pivotally mounted on the handle shaft **153** and also straddle the ratchet wheel **149**. A pin **165** extending between the stop links **163** forms a stop pawl which engages the ratchet teeth **161**. A tension spring **167** biases the drive links and the stop links against opposite sides of the ratchet wheel **149**. As the handle **151** is pulled away from the molded casing **3**, the drive pin engages a tooth **161** on the ratchet wheel and incrementally rotates the cam assembly. As the handle is returned toward the casing **3** upon the completion of the stroke, the stop pawl **165** engages a tooth on the ratchet wheel to prevent the ratchet wheel from reverse rotation. Thus, by repeated strokes of the handle **151**, the energy storage springs **79** are charged.

The operation of the circuit breaker **1** can be best understood through reference to the FIGS. **3A** through **3D**. FIG. **3A** illustrates the circuit breaker with the separable contacts **13** open and the energy storage springs **79** uncharged. Thus, the contact arm **27** is shown in the open position. It can also be seen that in this position the latch mechanism **19** is latched with the first leg **139** of the Y-latch member **135** engaging the D-shaft **123**. It can also be seen that under these conditions the cam assembly **59** is rotationally positioned so that the cam lobes **105** on the drive cam are positioned away from the cam follower **107** on the moving contact assembly **25**. It can be further seen that the rollers **101** on the follower link **63** engage the spring cams **73** at the minimum radius point of the charging portion **103*c*** on the cam profile of the spring cams **73**. Through reciprocal operation of the handle **151**, the cam assembly is incrementally rotated counterclockwise as viewed in FIG. **3A**. As the spring cams **73** rotate, the radius of the charging portion **103** of the cam profile increases so that the follower link **63** rotates counterclockwise to compress the energy storage springs **79**. As mentioned, as the springs **79** become fully charged, the radius of the charging portion **103**C of the spring cam profile in contact with the rollers **101**, begins to decrease so that the assembly begins to act like a motor as the springs exert a force through the follower link **63** tending to drive the cam assembly **59** in the counterclockwise direction as shown in FIG. **3**B. However, this continued counterclockwise rotation of the cam assembly is blocked by engagement of the second leg **143** of the Y-latch member **135** which engages the stop **75**. Thus, as shown in FIG. **3**B, the energy storage springs **79** are fully charged and the contact arm **27** remains in the open position.

In order to close the separable contacts **13**, the push button **133** is depressed. This rotates the D-shaft **123** counterclockwise causing the first leg **139** of the Y-latch member **135** to pass through the notch **125** under the bias of the spring **141** thereby lifting the second leg **143** out of engagement with the stop **75**. With the rollers **101** now bearing against the energy release portion **103**R of the cam profile on the spring cams **73**, the energy storage springs **79** rapidly rotate the cam assembly **59** counterclockwise. As the lobes **105** on the drive cams **71** approach the cam follower **107**, the rollers **111** engage the leading edge **113** of these lobes and roll inwardly along this leading edge initially as the lobes continue to rotate and rotate the contact arm assembly **25** clockwise toward the closed position. With continued rotation of the cam assembly **59**, the rollers **111** roll up onto the peripheral edge of the cam lobes **105** to drive the moving contact assembly **25** to the fully closed position as shown in FIG. **3**C. As the cam assembly **59** rotates from the position shown in FIG. **3**B to that shown in FIG. **3**C, the second leg **143** of the Y-latch member **135** is engaged by the stop **75** which rotates the Y-latch member clockwise back to the latched position for engagement with the D-shaft **123** which is also returned to the latched condition by the torsion spring **127**. As the cam assembly **59** reaches the rotational position shown in FIG. **3**C, further rotation is prevented by engagement of the second leg **143** of the Y-latch member **135** with the second stop **77**. Thus, the mechanism is latched in the closed position. It will be seen that the energy storage springs **79** remain partially charged at this point. It can also be appreciated that at this point the opening spring **65** has been charged by the closing of the open contact assembly **25**.

Depressing of the push button **133** a second time results in unlatching of the latching mechanism **119** in the manner similar to that described above so that the energy storage spring **79** continues to rotate the cam assembly **59** in the counterclockwise direction back to the position as shown in FIG. **3**A. When the rollers **111** on the cam follower **107** reach the end of the cam lobes **105**, they pass into the recess **117**. Upon disengagement of the cam follower from the cam lobes **105**, the opening spring **65** rotates the moving contact assembly **25** to the open position as shown in FIG. **3**A. Thus, it can be seen that depressing the push button **133** a first time results in closing of the separable contacts **13** and depressing it a second time opens the contacts.

Should a short circuit occur while the circuit breaker is in the closed position shown in FIG. **3**C, the magnetic repulsion forces produced by such a high current exert an opening force on the contact arm **27**. This force overcomes the force exerted by the coupling pin **51** so that the contact arm rotates to the open position while the contact carrier **35** remains in the closed position as shown in FIG. **3**D. This occurs very rapidly before the trip mechanism of the circuit breaker has responded to the overcurrent condition. However, when the trip mechanism generates a trip signal, the latch mechanism is unlatched so that the energy storage springs **79** rotate the cam assembly **59** to the position shown in FIG. **3**A. This allows the opening spring **65** to rotate the contact arm carrier **35** to the open position of FIG. **3**A. As this occurs, the blow open coupling **47** reengages the contact arm.

The invention makes possible a molded case circuit breaker with a higher current rating than is currently available by providing energy storage springs for closing the separable contacts of the breaker. The same energy storage springs are also utilized to initiate opening of the circuit breaker, although the actual rotation of the moving contact assembly to the open position is accomplished by an opening spring. The operating mechanism incorporating the energy storage springs is compact enough that it can be inserted into existing molded case circuit breaker housings. Furthermore, the operating mechanism is designed for low cost and ease of manufacture. All of the components are mounted on shafts captured between the two side plates and separate fasteners are not required. This arrangement also fixes the positions of the parts thereby eliminating the need for adjustments.

While specific embodiments of the invention have been described in detail, it will be appreciated by those skilled in the art that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangements disclosed are meant to be illustrative only and not limiting as to the scope of invention which is to be given the full breadth of the claims appended and any and all equivalents thereof.

What is claimed is:

1. An electric power switch comprising:

a molded casing;

at least one pole mounted in said molded casing and comprising:

a set of separable contacts including a stationary contact and a moveable contact; and

a moving contact assembly on which said moveable contact is mounted and moveable between a closed position in which said separable contacts are closed and an open position in which said separable contacts are open;

an operating mechanism mounted in said molded casing and comprising:

a cam assembly including a cam shaft and a drive cam mounted on said cam shaft;

an energy storage spring; and

coupling means coupling said energy storage spring to said cam assembly to rotate said cam shaft and with it said drive cam, said drive cam having a cam lobe configured to engage and move said moving contact assembly to said closed position closing said separable contacts as said cam assembly is rotated by said energy storage spring to a closed position, and configured to release said moving contact assembly through further rotation of said cam assembly including said drive cam by said energy storage spring to an open position; and

an opening spring biasing said moving contact assembly to said open position.

2. The electric power switch of claim **1** wherein said moving contact assembly includes a drive cam follower which is engaged by said cam lobe and which pivots about a fixed pivot, said cam shaft being positioned relative to said fixed pivot so that said cam follower rotates in an arc which initially brings said cam follower closer to said cam shaft as said drive cam follower is engaged by said cam lobe, said cam lobe having a leading edge configured to allow said cam follower to move toward said cam shaft initially as said cam lobe engages said cam follower through rotation of said drive cam.

3. The electric power switch of claim **2** wherein said leading edge of said cam lobe is configured to be generally radial to said cam shaft.

4. The electric power switch of claim **3** wherein said drive cam lobe has a trailing edge forming a recess which provides clearance for said cam follower allowing said opening spring to open said separable contacts as said drive cam is rotated past said closed position.

5. The electric power switch of claim **1** wherein said moving contact assembly comprises a contact arm having a first free end on which said moveable contact is mounted and a second end, and means mounting the second end of said contact arm for rotation of said contact arm about said fixed pivot.

6. The electric power switch of claim **5** wherein said means mounting said contact arm comprises a contact arm carrier pivotally mounted for rotation about said fixed pivot and said moving contact assembly further comprises a drive cam follower projecting from said contact arm carrier and which is engaged by said drive cam, said contact arm being releasably pivotally mounted on the contact arm carrier for blow open relative to said contact arm carrier in response to magnetic repulsion forces generated by short circuit current through said set of separable contacts.

7. The electric power switch of claim **6** in which said cam shaft is positioned relative to said fixed pivot so that said drive cam follower rotates in an arc which initially brings said drive cam follower closer to said cam shaft as said drive cam follower is engaged by said cam lobe, said cam lobe having a leading edge which extends generally radially to said cam shaft.

8. The electric power switch of claim **1** wherein said cam assembly includes a spring cam fixed on said cam shaft, said coupling means comprises a link engaging said energy storage spring and said spring cam, and said operating mechanism includes spring charging means coupled to said cam shaft, said spring cam having a cam profile with a charging portion over which said spring stores energy with rotation of said spring cam by said charging means, and an energy release portion over which said spring releases energy to rotate said spring cam and with it said drive cam, said operating mechanism further including a latch mechanism latching said cam assembly in said charged position with said spring fully charged, and also latching said cam assembly including said drive cam in said closed position in which said separable contacts are closed.

9. The electric power switch of claim **8** wherein said latch mechanism comprises a latch which is actuated a first time to close said separable contacts and is actuated a second time to open said separable contacts, and a latch member having a first leg which is engaged by said latch to latch said latch member and is released by said Y-latch to unlatch said latch member, a second leg which engages a first stop on said cam assembly to retain said cam assembly in the charged position until said latch is released said first time, and which engages a second stop on the cam assembly to retain said cam assembly in the closed position until said latch is released said second time, and a third leg which is engaged by said cam assembly to relatch said latch member following release of said latch said first and second times.

10. The electric power switch of claim **9** wherein said latch member is pivotally mounted and has a spring biasing said latch member to an unlatched position, said third leg being engaged by said first stop on said cam assembly to relatch said latch member as said cam assembly rotates toward said closed position following release of said latch said first time, and said third leg being engaged by said second stop on said cam assembly to relatch said latch member as said cam assembly rotates past said closed position following release of said latch said second time.

11. The electric power switch of claim **10** wherein said first stop and said second stop are both mounted on said drive cam.

12. The electric power switch of claim **8** wherein said spring charging means includes a rachet wheel mounted on said cam shaft and a handle mechanism for engaging said rachet wheel to incrementally rotate said cam shaft to charge said energy storage spring.

13. The electric power switch of claim **12** wherein said operating mechanism includes a pair of side plates mounted within said molded casing, and wherein said cam assembly, said energy storage spring, said coupling means, said latch mechanism, said rachet wheel, and said handle mechanism are all mounted between and supported by said side plates.

14. The electric power switch of claim **8** wherein said spring charging means includes a rachet wheel and means for incrementally rotating said rachet wheel to charge said energy storage spring, and wherein said operating mechanism includes a pair of slide plates, and said cam assembly, said energy storage spring, said coupling means, said latch mechanism and said rachet wheel are all mounted between and supported by said side plates.

15. The electric power switch of claim **1** having multiple poles each having a set of separable contacts and a moving contact assembly, and including a cross-bar connecting said moving contact assemblies of said multiple poles together for simultaneous movement, said operating mechanism engaging and moving said moving contact assembly of one of said poles, the moving contact assemblies of the other poles being moved by said cross-bar.

* * * * *